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WTS-1B: GENERAL CRITERIA FOR PREPARING AN EFFLUENT MANAGEMENT PLAN

GENERAL NOTES:

The Nevada Division of Environmental Protection (NDEP) must be contacted whenever the use of reclaimed water is planned in order to determine the appropriate regulatory oversight requirements. NDEP shall also be available to assist the applicant in preparing the effluent management plan (EMP).

The Nevada Division of Water Resources (775) 687-4380 must be notified of the plan to use reclaimed water in order to address requirements for secondary water rights. Also, the Nevada State Health Division (775) 687-4754 should be consulted to ensure the use of reclaimed water is consistent all water supply protection requirements. Finally, please be aware that the local government and water purveyor may have rules on reclaimed water usage and should be consulted.

GUIDANCE INTRODUCTION:

Pursuant to NAC 445A.275.1(b), NDEP must issue a discharge permit for the use of reclaimed water. As part of this permitting process, NAC 445A.275.1(a) states that an EMP must be submitted and approved prior to the use of reclaimed water. This guidance was prepared to assist the permittee in preparing a satisfactory EMP. Please be aware that the extent of information and content for each individual EMP will vary for the different types of reclaimed water use, so not all portions of this guidance may apply to your particular EMP.

This guidance was organized to cover only existing usages of reclaimed water in Nevada. Items that the Division deems a requirement are so marked in the document and items that are simply recommendations are so marked. Information on any guidance referenced in WTS-1B may be gathered by contacting this Bureau.

Past guidance documents for reclaimed water use (WTS-1, WTS-9, and the outline format), are now effectively replaced by this guidance and WTS 1A (General Design Criteria for Reclaimed Water Irrigation Use). This Guidance is considered a dynamic document, and revisions may be made in the future as changes in reclaimed water usage regulations dictate.

Thanks is given to the Reuse Nevada Committee for their assistance in helping NDEP prepare this guidance.

The EMP is intended for use by the reuser (golf course superintendent, farmer, park maintenance worker, industrial worker, etc.) so it should be written in a user friendly format. The use of illustrative figures, maps, and tables throughout the EMP is highly recommended. The EMP should be bound in a loose leaf binder to facilitate updates. The date of printing for the EMP and all subsequent revisions must be shown on the title page of the EMP.

This document does not replace best professional judgement in reuse system management and NDEP reserves the right to require further information and review additional factors as needed.

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KEYWORDS

AIR GAP:

Generally, the safest method of back flow prevention control. For this document, it is defined to be an unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe conveying potable water to the flood level rim of any container with treated effluent. The Uniform Plumbing Code details the requirements for Air Gaps and enforcement is the role of the local water purveyor and/or health authority.

BUFFER ZONE:

NAC 445A.076 defines a buffer zone to be the shortest distance between the boundary of the site being irrigated with reclaimed water and either; **one**, the property line boundary of the site; **two,** a posted public warning sign, or; **three**, any point where the property is open to public access, whichever is least. NAC 445a.276 lists the various buffer zones for spray irrigation sites based on reclaimer water quality and type of site being irrigated.

DMR: Discharge Monitoring Report. A table-formatted report where results from permit sampling and monitoring are recorded for submittal to NDEP.

FECAL COLIFORM:

Bacteria from feces of mammals which is used as an indicator of pathogenic organisms.

RECLAIMED WATER:

Domestic Wastewater that has been treated to secondary treatment standards and disinfected to levels necessary (per NAC 445A.276, 277, and 278) for the chosen method of reuse. Other terms for this water include Treated Effluent, Reuse Water, and Recycled Water.

SAR : Sodium adsorption Ratio, a ratio determined from the concentration (milliequivalents/liter) of sodium, calcium, and magnesium in water. It is used as an indicator of potential soil problems.

$$\mathbf{SAR} = \frac{Na}{[(Ca + Mg)/2]^{1/2}}$$

A modification of this ratio, termed the adjusted SAR, considers the changes in calcium solubility in soil water. The procedure for determining this ratio is listed in Wastewater Engineering Treatment, Disposal and Reuse. 1991.

SOIL LEACHING:

Irrigation practice of applying water to soils in an effort to drive salts beyond the crop root zone. The rate is a function of crop salinity tolerance and salt level in irrigation water.

SPRAY IRRIGATION:

For purposes of this guidance, spray irrigation is categorized into three types; solid set (golf courses), move-stop (wheel lines), and constant move (center pivot) systems.

SURFACE IRRIGATION:

Surface irrigation is categorized as either flood irrigation or drip irrigation. Flood irrigation is further subdivided into ridge/furrow systems and graded borders.

GENERAL ITEMS FOR ALL EMP'S

REQUIREMENTS:

A. Overview of Project

A comprehensive overview of the reclaimed water application for the project. Outline the distribution system, application site, application method, and permit responsibilities. Use figures to illustrate the general system layout.

B. Staff Listing

A listing of supervisors and key responsible staff at the reuse site, including a description of their accompanying responsibilities. This list shall include each person's phone number, cell phone number, mailing address, and e-mail address (if available).

C. Discharge Permit

A complete copy of the active ground water discharge permit issued by this Division shall be inserted into the EMP.

D. Reuse Provider - User Agreement (If Applicable)

A copy (if applicable) of the reuse agreement between the reclaimed water supplier and the user/permit holder. This agreement should include an updatable copy of the reclaimed water quality analysis and special restrictions that may be in place on the reuse.

E. Communication Procedure

The communication procedure(s) between all parties involved in the transfer of reclaimed water, storage of reclaimed water, and use of reclaimed water shall be outlined in the EMP.

F. Hygiene

A brief document describing the proper hygiene of working with reclaimed water. This document should be written in English and any other languages deemed appropriate for the site. (Sample documents are provided in Appendix 4)

G. Reclaimed Water Run-Off Control Plan

1. Identification of areas where a release off the site may occur and how it will be detected (daily rounds, pressure readouts, etc.).

2. Steps that will be taken to control the release.

3. Phone numbers for key personnel involved in the release response plan and persons who are responsible for reporting the release to NDEP.

G. Reclaimed Water Run-Off Control Plan (continued)

4. Description of the permit requirements for reporting a release to NDEP. This includes notification by phone, at (775) 687-4670, ext 3143, as soon as the release is identified and controlled (within 24 hours). Also, a written report on the release (discharge) and the methods used to mitigate the release must be submitted to the NDEP within five days. This report shall list:

   i. the time and date of the discharge;
   ii. exact location and estimated amount of discharge;
   iii. flow path and bodies of water which the discharge reached;
   iv. the specific cause of the discharge; and
   v. the preventive and/or corrective actions taken.

H. Cross Connection and Back Flow Prevention (If applicable)

Summarize the cross connection control plan and back flow prevention plan that has been accepted by the Health Authority and/or water purveyor. Reference all figures that show these controls.

I. Discharge Monitoring Reports (DMR'S)

Outline of the procedure for completing the permit required DMR from field readings and laboratory data sheets. This section shall include a sample DMR to guide the reuser.

RECLAIMED WATER IRRIGATION - GENERAL ITEMS

A. Irrigation Plan

Provide a summary of the irrigation plan for the site(s). This summary shall detail the times of irrigation, the application rates, and flow measuring procedures. Critical focus shall be given to preventing run-off of reclaimed water from the site(s) and reducing reclaimed water ponding. For sites using automated or computer controlled irrigation systems, please include a brief description of how the system operates.

Depending upon the site type and physical location, several items that should be addressed in the irrigation plan are:

1. A plan to avoid irrigation during or just after significant precipitation events.

2. A plan to provide sufficient drying time for soils (after irrigation) before allowing animal grazing. It's recommended that the grazing periods be limited, to the best extent possible, to reduce soil compaction.

3. Plans to harvest crop(s) annually (if applicable).

4. A plan to prevent irrigation on frozen soils or saturated soils.

B. Site Maps

A detailed site map for the irrigation site(s). This map shall delineate the surrounding water courses, storm water controls, buffer zones (if applicable), prevailing wind direction, surrounding dwelling units, and any wells within 250 feet of the reuse site boundary.

C. Irrigation System

Schematic or scaled map of the reuse site that shows the conveyance system and components for the reclaimed water. This includes details on the location of control valves, drain valves, air gaps, flow meters, pumps, and other key components that the reuser will operate and maintain.

D. Ponds

Operation and maintenance plan for the reclaimed water storage ponds (if applicable). Items to address could include water level recording devices and storage volume estimates, algae control, odor control, reclaimed water transfer procedures, free board requirements, berm inspection, weed and rodent maintenance, flow recirculation, notification signage, and mechanical aeration (Note: the generation of aerosols from aeration equipment should be minimized to limit drift).

E. Treatment Systems

The operation and maintenance plans for treatment units that are required to meet permit limits are to be included in the EMP. This may include such units as sand filters, disinfection systems, or any chemical treatment systems.

F. Crop/Turf Management Plan

It is recommended that management plans addressing maintenance of a healthy crop be summarized in the manual. Items relevant to this pursuit include soil leaching practices, soil amendment applications, soil chemistry monitoring, and other specific procedures for the site's crop. Please contact the local agricultural agency for guidance.

G. Storm Water

Storm water control structure maintenance. This shall include a maintenance program for diversion berms, conveyance ditches, and pump systems (if applicable).

H. Sampling

Sampling plans required by the permit must be outlined in the EMP. The proper QA/QC for sample preservation, sample holding times, sample containers, and chain of custody

This includes the procedures for collecting a ground water sample from a monitoring well and reclaimed water samples. A groundwater sampling protocol guidance is available from the Division.

I. Water Balance

Completion of a water balance is required by reuse permits. The procedures for completing the water balance summary for the site(s) must be clearly outlined in the EMP. Completed worksheet "1-B" from Appendix One, or a comparable form, should be included to present the design assumptions and to provide guidance for filling out subsequent reporting forms. Blank worksheets should also be included. Sample forms are attached in Appendix One. Information from these worksheets can be used by the permittee in completing the Annual Report which is typically required to be submitted with the fourth quarter DMR.

J. Nitrogen Balance

Completion of a nitrogen balance is required by reuse permits. The procedures for computing the total amount of nitrogen applied to the site(s) must be clearly outlined in the EMP. This shall include the mass of nitrogen applied from the reclaimed water and fertilizers. Completed Worksheet "2-B" from Appendix Two, or a comparable form, should be included to present the design assumptions and to provide guidance for filling out subsequent reporting forms (Worksheet "2-C" and DMR forms). Blank worksheets should also be included. Sample forms are attached in Appendix Two. Information from these worksheets can be used by the permittee in completing the Annual Report which is typically required to be submitted with the fourth quarter DMR.

K. Signage

Any site using reclaimed water for irrigation shall post a notice warning the general public to avoid contact with the reclaimed water (NAC 445A.275.3). Signage examples are included in Appendix Five for reference. Score cards at golf courses are one option for providing notification to the public that reclaimed water is being used for irrigation.

ADDITIONAL RECLAIMED WATER IRRIGATION ITEMS FOR:

SPRAY IRRIGATION

A. Run-Off Containment Berms

Maintenance plan for containment berms that serve to prevent the surface flow of reclaimed water off the site boundary (NAC 445A.275.6) if there is a significant line break or other failure. These berms are site specific requirements and therefore may not apply to your site.

B. Freezing Weather Protection

Depending upon the site location, necessary maintenance items to prevent freezing and damage to the distribution system should be included. Items to address are piping insulation, drains, or valve enclosures.

C. Drinking Water Fountain Protection and Food Serving Areas

Plans to cover drinking water fountains located on the reuse site prior to the start of irrigation shall be included. Additionally, plans to shield areas where food is handled should be presented.

NOTE:

Reclaimed water meeting a 30-day geometric mean **total coliform limit** of 2.2 mpn (cfu)/100 ml and a daily max of 23 mpn (cfu)/100ml has no buffer zone or public access control restrictions (NAC 445A.277). Please refer to Appendix Six for the regulation.

The following items (D thru F) apply **only** to Category A, A(1), B, and C waters as listed in NAC 445A.276.

D. Buffer Zone Controls

Describe the required buffer zones for the quality of reclaimed water used (see table on next page). Also, list procedures for maintaining spray irrigation within these zones. The irrigation plan should control the drifting of aerosols beyond the buffer zones (NAC 445A.275.5).

E. Irrigation Scheduling

Irrigation under Category B and C criteria (see regulations) shall be conducted during the nighttime hours and the public shall be restricted from entering the site during the irrigation period.

Treated effluent irrigation for golf courses shall only take place during times after the course is closed and shall cease one hour before the course opens for play in the morning. The irrigation system can be operated briefly during daylight hours when golfers are not present or approaching provided the operator ensures that the public are not exposed to effluent spray or wet grass. Daytime irrigation system operation shall be supervised at the site of irrigation by course personnel at all times.

Specific areas within the site that are first accessed (example: first few holes on golf course) by the public should be irrigated during the initial stages of the watering cycle to allow drying time before the public is permitted to enter.

F. Spray Irrigation with Reclaimed Water Under Category A, A(1), B, and C:

1. Plans to control public *access* to the irrigation site during times of reclaimed water application are required. Relevant items include fencing, adherence to the required buffer zones, and notification of reclaimed water usage. The quality of reclaimed water will dictate the level of access controls (see Table Below) .

2. Plans to control public *contact* with reclaimed water at the site are required. Relevant items include prevention of ponded water, notification signage, irrigation scheduling (ex. night time irrigation), and notification of reclaimed water usage on scorecards, signage or other related documents available to the public. Quality of reclaimed water will dictate level of contact controls required (see Table Below).

Category A	Category A(1)	Category B	Category C
Public Access is prohibited during irrigation periods. No human contact due to site isolation.	Public Access is prohibited during irrigation periods. No human contact due to site isolation.	Public Access is Controlled. Human contact with reclaimed water does not occur.	Public Access is Controlled**.** Human contact with reclaimed water cannot reasonably be expected to occur.
Pasture Lands, other agricultural uses	Pasture Lands, other agricultural uses	Golf courses, green belts, cemetery, and other areas	Areas covered in all categories, plus parks, playgrounds, commercial lawns, and residential lawns.
800 ft. Buffer Zone	**400 ft. Buffer Zone**	**100 ft. Buffer Zone**	**0 ft. Buffer Zone**
30 day Fecal Coliform Geometric Mean equal to or less than: no limit,	**30 day Fecal Coliform Geometric Mean equal to or less than: 200 mpn (cfu)/100ml. Daily Max: 400 mpn (cfu) /100ml**	**30 day Fecal Coliform Geometric Mean equal to or less than: 23 mpn (cfu)/100ml. Daily Max: 240 mpn (cfu)/100 ml**	**30 day Fecal Coliform Geometric Mean equal to or less than: 2.2 mpn (cfu)/100ml. Daily Max: 23 mpn (cfu)/100 ml**

ADDITIONAL RECLAIMED WATER IRRIGATION ITEMS FOR:

SURFACE IRRIGATION

A. **FLOOD IRRIGATION**:

1. Irrigation Methodology

   Operational plan(s) for flow distribution. Relevant items to address include promoting even spreading of reclaimed water over the site(s), reducing soil erosion at the distribution points, and operation of the tailwater recovery system operation (if applicable).

2. Containment Berms and Detention Areas

   A maintenance plan and inspection schedule for containment berms and detention areas (NAC 445A.275.6) that are in place to prevent the run-off of the reclaimed water from the site(s) is required.

B. **DRIP IRRIGATION**

1. Irrigation Methodology

   Operational plan for flow distribution. Relevant items include site inspections (checking for line breaks, etc.) and emitter line maintenance (clogging controls).

CONSTRUCTION USAGE

A. DUST CONTROL

1. Fecal Coliform Levels

   The typical minimum fecal coliform limits for this application are 23 mpn (cfu)/100 ml for the 30 day geometric mean and 240 mpn (cfu)/100 ml for a daily maximum. However, each facility's permit will specify the permissible fecal coliform limit.

2. Application Items

   Plans for controlling the application rate shall address the prevention of ponded reclaimed water. Also, a plan to control the generation of aerosols and the migration of aerosols from the site(s) should be developed. Methods to prevent the application of reclaimed water near water courses (rivers, streams, and lakes) must be presented.

3. Tank Trucks

   Tank trucks and other equipment which hold reclaimed water shall be properly identified with notification signs. **Tank trucks that carry reclaimed water shall not be used to carry potable water**. It is recommended that the tanks be cleaned and disinfected after the project is complete. Please consult the State or local health authority on rules that may be in place for this criteria.

INDUSTRIAL USAGE

A. COOLING WATER

1. Fecal Coliform Level

   The typical minimum fecal coliform limits for this application are 23 mpn (cfu)/ 100 ml for a 30 day geometric mean and 240 mpn (cfu)/100 ml for a daily maximum. However, each facility's permit will specify the permissible fecal coliform limit.

2. Application Items

   List operational controls to reduce aerosol drift.

   NDEP recommends that facilities institute operational methods for treatment (lime addition, alum, etc.) to handle scaling, corrosion, fouling, and biological growth throughout the system. This will help reduce line clogging and other system problems. Also, if algae growth is a concern, chlorine can be used to control algae growth provided the water is not discharged to a water course. This should also help reduce the formation of Legionella.

OTHER USES OF RECLAIMED WATER

A. Site specific management plans for the use of reclaimed water will be considered on a case by case basis with appropriate controls and requirements determined by the NDEP.

WTS-1B: APPENDIX ONE

PLANT CONSUMPTIVE USE WORKSHEET

The consumptive use equation for determining the crop's water requirement takes into account precipitation, evapotranspiration, the efficiency of the irrigation system, and the salt tolerance of the plant species. The salt tolerance of the plant species is used to calculate the leaching requirement (Lr) to remove excess salts from the root zone. Excess salts within the soil cause the plant cells to expend more energy adjusting the salt concentration within the plant tissues, and therefore, less energy is available for vigorous plant growth. The hydraulic loading rate and the TDS to ECw conversion equation included below are derived from Wastewater Engineering: Treatment, Disposal, and Reuse, (Metcalf and Eddy, 1991), the equation for the leaching requirement is from the Nevada Irrigation Guide, (USDA, Soil Conservation Service, 1981).

$$Lw_{(c)} = \frac{(ET-P)}{[E \times (1-Lr)]} \qquad Lr = \frac{ECw}{[(5 \times ECe)-ECw]}$$

where:

- $Lw_{(c)}$ = Allowable Hydraulic Loading Rate Based on Crop Water Needs (in/yr);
- ET = Evapotranspiration Rate (in/yr);
- P = Precipitation Rate (in/yr);
- Lr = Leaching Requirement (%, expressed as a fraction);
- E = Efficiency of Irrigation System (%, expressed as a fraction)
  For example: 75% = 75/100 = 0.75; example efficiencies are included below;
- ECe = Salinity Tolerance of Plant Crop (mmho/cm or dS/m)[1];
- ECw = Salinity of Applied Effluent (mmho/cm); If TDS is supplied by the laboratory, see conversion below; and
- TDS = Average Total Dissolved Solids in Applied Effluent (mg/l).

"ET" - Evapotranspiration

Evapotranspiration is defined as the "loss of water from the soil both by evaporation and by transpiration from the plants growing thereon" (Websters Dictionary, 1990). Since different plants transpire at different rates, a crop coefficient (Kc) can be used to modify the potential ET for a particular area. Values for Kc vary depending upon the geographical location of the crop, and the species grown. If a crop coefficient can be determined, when multiplied by the potential ET rate, the result is a more accurate estimate of ET for an irrigation site. The Division recommends that reusers contact local agriculture representatives identified in Appendix Five for further crop-specific and regional information.

"E" - Irrigation Efficiency

The irrigation system efficiency is related to how effective the method is in delivering the irrigation water equally to all parts of the crop. Example values for efficiency are[4]:

Sprinkler Irrigation Type	**Application Efficiency**	**Surface Irrigation Type**	**Application Efficiency**
Solid Set	0.70 - 0.80	Narrow Graded Border (< 15' wide)	0.65 - 0.85
Portable Hand Move		Wide Graded Border (<100' wide)	0.65 - 0.85
Wheel Roll		Level Border	0.75 - 0.90
Center Pivot or Traveling Lateral		Straight or Graded Contour Furrows	0.70 - 0.85
Traveling Gun		Drip	0.70 - 0.85

"Ece" - Salinity Tolerance of Plant Crop

The plant salt tolerance is crop-specific, and can be obtained from the local Extension Service, literature, or other reputable sources. The low end of the range identifies the ECe value which would result in a 0% reduction of crop yield. The upper end of the range identifies the ECe value which could result in a 25% reduction of crop yield[4].

Example ECe's:

Annual Ryegrass[2]	=	3 to 6 mmho/cm or dS/m
Perennial Ryegrass[2,4]	=	5.6 to 8.9 mmho/cm or dS/m
Bermudagrass[2,4]	=	6.9 to 10.8 mmho/cm or dS/m
Tall Fescue[2,4]	=	3.9 to 8.6 mmho/cm or dS/m
Alfalfa[3,4]	=	2.0 to 5.4 mmho/cm or dS/m

"ECw" - Salinity of Applied Effluent

Direct measurement of ECw is typically preferred. However, if the laboratory has supplied the reuser with a concentration of TDS, an approximate conversion[4] is ECw ≈ TDS ÷ 640. This conversion is considered accurate within 10%. The value for ECw or TDS is obtained from the treatment plant supplying the effluent. For site design, an average value can be used. For completion of the required annual balance report, the actual analytical results from Discharge Monitoring Reports should be used.

(1) For clairty in this document, the unit for electrical conductivity (EC) is expressed as mmho/cm. However, EC can also be expressed in decisiemens per meter, dS/m.
1 mmho/cm = 1 dS/m

(2) Wastewater Reuse for Golf Course Irrigation, US Golf Association, 1994.

(3) Nevada Irrigation Guide, USDA Soil Conservation Service, 1981.

(4) Wastewater Engineering: Treatment, Disposal, and Reuse, (Metcalf and Eddy, 1991)

Worksheet 1-A

CONSUMPTIVE USE REQUIREMENT WORKSHEET:
Maximum Loading Rate Based on Plant Water Use Requirements

Page _____ of _____ Crop Type = _____

$Lw_{(c)} = \frac{(ET-P)}{[E \times (1-Lr)]}$; $Lr = \frac{ECw}{[(5 \times ECe)-ECw]}$; $ECw \approx TDS \div 640$

(A) Annual Evapotranspiration (ET, in/yr) = _____
(Multiply by Crop Coefficient (Kc) if value is known)

(B) Annual Precipitation (P, in/yr) = _____

(C) (A) - (B) = _____ (in/yr)

(D) Salinity of Applied Effluent (ECw, mmho/cm) or ≈ (TDS, mg/l) ÷ 640 = _____
(Indicate which method was used to determine ECw, Direct Measurement or Approximation by Calculation.)

(E) Salinity Tolerance of Plant Crop (ECe, mmho/cm) = _____

(F) 5 x (E) = _____ (mmho/cm)

(G) (F) - (D) = _____ (mmho/cm)

(H) Leaching Requirement (Lr, %, expressed as a fraction) = (D) ÷ (G) = _____

(I) 1 - (H) = _____

(J) Efficiency of Irrigation System (E, %, expressed as a fraction) = _____

(K) (J) x (I) = _____

(L) (C) ÷ (K) = $Lw_{(c)}$ = _____ (inches/year)

If the water use rate calculated in ("L") above is the lowest application volume calculated between the annual Consumptive Use Limit (This Worksheet) and the Nitrogen Limit (Worksheet 2-A), then fill out Worksheet 1-B to estimate the planned maximum daily flow for the site.

Worksheet 1-B

CONSUMPTIVE USE REQUIREMENT WORKSHEET:
Maximum Loading Rate Based on Plant Water Use Requirements

Page _____ of _____ Crop Type = _____

$Lw_{(c)} = \frac{(ET-P)}{[E \times (1-Lr)]}$; $Lr = \frac{ECw}{[(5 \times ECe)-ECw]}$; $ECw \approx TDS \div 640$

Monthly values for evapotranspiration are dependent on the crop type and regional area of the site, as well as the crop coefficient if known. Monthly precipitation is also regional. The values for ET and P can be obtained from the local extension service, literature, or other reputable source. Please see the explanation in the "WTS-1B: Appendix One" text for futher discussion of crop coefficients.

To calculate the monthly value for $Lw_{(c)}$, perform the calculation for each month as outlined in Worksheet 1-A, and input the result in the table below. Since this form is crop-specific, a value of zero is acceptable when the crop is not in season; however, use of a zero should be explained.

Million Gals/Mo = $Lw_{(c)}$ in/mo x _____ ac ÷ 12 in/ft x 43,560 ft^2/ac x 7.481 gals/ft^3 ÷ 1,000,000
(Enter and use the number of acres for the crop type being irrigated)

MGD (Million gallons/day) = M Gallons/mo ÷ Days/mo

Month	Days/Mo	ET (in/mo)	P (in/mo)	$Lw_{(c)}$ (in/mo)	M Gals/Mo	MGD
Jan	31					
Feb	28					
Mar	31					
Apr	30					
May	31					
Jun	30					
Jul	31					
Aug	31					
Sep	30					
Oct	31					
Nov	30					
Dec	31					
Totals (in/yr):					Note: These totals should approximate the annual values calculated in Worksheet 1-A	

WTS-1B: APPENDIX TWO

NITROGEN LOADING LIMIT WORKSHEET

The nitrogen loading equation takes into account precipitation, evapotranspiration, plant nitrogen uptake, nitrogen content of the applied effluent, nitrogen denitrification and volitilization in the soils, and allowable percolate nitrogen concentration. The equation included below is from Wastewater Engineering: Treatment, Disposal, and Reuse, (Metcalf and Eddy, 1991)

$$Lw_{(n)} = \frac{[(Cp, mg/l) \times (P\text{-}ET, in/yr)] + [(U, lb/acre\text{-}yr) \times (4.4)]}{[(1\text{-}f) \times (Cn, mg/l)] - (Cp, mg/l)}$$

where:

$Lw_{(n)}$ = Allowable Hydraulic Loading Rate Based on Nitrogen Loading rate (in/yr);
Cp = Total Nitrogen Concentration in Percolating Water (mg/l);
ET = Evapotranspiration Rate (in/yr);
P = Precipitation Rate (in/yr);
U = Nitrogen Uptake Rate by Crop (lb/acre-yr);
4.4 = Combined Conversion Factor;
Cn = Total Nitrogen Concentration in Applied Wastewater (mg/l); and
f = Fraction of Applied Total Nitrogen Removed by Denitrification and Volatilization.

"Cp" - Nitrogen in Percolating Water

A conservative value for Total N in the water that percolates past the root zone (Cp) is 7 mg/l, which is the first "red flag" value for Nitrate as N in monitoring well samples. Setting the Cp limit at a constant value aids in obtaining an hydraulic nitrogen loading rate ($Lw_{(n)}$) which should be protective of groundwater resources. The drinking water standard for Nitrate as N is 10 mg/l, which would be the maximum allowable value for Cp.

"ET" - Evapotranspiration

Evapotranspiration is defined as the "loss of water from the soil both by evaporation and by transpiration from the plants growing thereon" (Websters Dictionary, 1990). Since different plants transpire at different rates, a crop coefficient (Kc) can be used to modify the potential ET for a particular area. Values for Kc vary depending upon the geographical location of the crop, and the species grown. If a crop coefficient can be determined, when multiplied by the potential ET rate, the result is a more accurate estimate of ET for an irrigation site. The Division recommends that reusers contact local agriculture representatives identified in Appendix Five for further crop-specific and regional information.

"U" - Crop Nitrogen Uptake

Plant nitrogen uptake rates (U) are crop-specific, and can be obtained from the local Extension Service, literature, or other reputable sources. Using the accepted value for U in this equation assumes that the harvested portion of the crop is removed from the site. If plant cuttings are not removed from the area, then the amount of nitrogen removed by uptake should be offset by the amout of nitrogen returned to the soil by decomposing cutting materials. If alfalfa, or another legume, is the site's crop, then similar considerations should be made for atmospheric nitrogen which is fixed into the soil by alfalfa. A discussion with the local agricultural extension service is recommended prior to finalizing a "U" value.

"Cn" - Nitrogen in Applied Wastewater

The total nitrogen in the applied effluent water (Cn) can be obtained from the treatment plant that is supplying the effluent. For site design, an average value can be used. For completion of the required annual balance report, the actual analytical results from Discharge Monitoring Reports shall be used.

"f" - Nitrogen lost to Denitrification and Volatilization

The amount of nitrogen lost to denitrification and volatilization varies depending upon the nitrogen characteristics of the applied wastewater and the microbial activity in the soil. Microbial denitrification, in soils with a sufficient carbon source for the biological activity, may account for as much as 15 to 25 percent of the applied nitrogen during warm, biologically active months. Volatilization of ammonia may be as much as 10 percent, depending upon the ammonia fraction in the total nitrogen applied. (Metcalf & Eddy, 1991) For arid climates, such as Nevada, the value typically used for the "f" term is 0.2.

Nitrogen Addition by Chemical Fertilizers

If the allowable reuse water application volume is limited by plant consumptive use (Worksheet 1-A), nitrogen may need to be added by commercial fertilizer. In the design of a reuse site, and preparation of an EMP, this should be estimated to provide the site operator with a guideline for fertilizer application, in addition to the nitrogen being applied via the treated effluent. **The application of fertilizer must then be incorporated into the required annual report to demonstrate that the application of commercial nitrogen and effluent nitrogen did not exceed the plant crop's uptake rate.**

Worksheet 2-C is designed to be used to provide the Division with the required annual report of effluent and fertilizer usage. Reuse permits require that the annual evaluation of the effluent application include, "the total nitrogen in the applied wastewater, nitrogen from fertilizer applications, nitrogen uptake by plant materials, evapotranspiration rate, precipitation rate, and fraction of applied nitrogen removed by denitrification and volatilization." While Worksheet 2-C does not take precipitation and evapotranspiration into account, the permittee should compare each year's P and ET rates to those that were used during the site design and EMP preparation phases to ensure that the original assumptions remain valid.

Worksheet 2-C can also be utilized as a site management tool to *estimate* the amount of commercial fertilizer which may be required in an upcoming month. However, use of the worksheet in this manner does not preclude the responsible use of good irrigation and nutrient management practices.

Worksheet 2-A

WATER REQUIREMENT DESIGN WORKSHEET:
Maximum Hydraulic Loading Rate Based On Annual Nitrogen Balance Evaluation

Page _____ of _____ Crop Type = _____

$$Lw_{(n)} = \frac{[Cp \times (P-ET)] + (U \times 4.4)}{[(1-f) \times Cn] - Cp}$$

(A) Total Nitrogen in Percolating Water (Cp, mg/l) = _____

(B) Annual Precipitation (P, in/yr) = _____

(C) Annual Evapotranspiration (ET, in/yr) = _____
(Multiply by Crop Coefficient (Kc) if value is known)

(D) (B) - (C) = ___-_____ (in/yr) (Note: In Nevada, P is less that ET; therefore a negative number is correct to use in this worksheet.)

(E) (A) x (D) = _____

(F) Crop Nitrogen Uptake (U, lb/ac-yr) = _____

(G) (F) x 4.4 = _____

(H) (E) + (G) = _____

(I) Fraction of Applied Total Nitrogen Lost to Denitrification and Volatilization (f) = _____

(J) 1- (I) = _____

(K) Total Nitrogen in Applied Effluent (Cn, mg/l) = _____

(L) (J) x (K) = _____

(M) (L) - (A) = _____

(N) (H) ÷ (M) = $Lw_{(n)}$ (inches/year) = _____

If the Water Use Rate calculated in ("N") above is the lowest application volume calculated for the annual Consumptive Use Limit (Worksheet 1-A) or the Nitrogen Limit (This Worksheet), then fill out Worksheet 2-B to estimate the planned maximum daily flow for the site.

Worksheet 2-B

WATER REQUIREMENT DESIGN WORKSHEET:
Maximum Hydraulic Loading Rate Based On Annual Nitrogen Balance Evaluation

Page _____ of _____ Crop Type = _____

$$Lw_{(n)} = \frac{[Cp \times (P-ET)] + (U \times 4.4)}{[(1-f) \times Cn] - Cp}$$

Monthly values for evapotranspiration are dependant on the crop type and regional area of the site, as well as the crop coefficient if known. Monthly precipitation is also regional. The values for ET and P can be obtained from the local extension service, literature, or other reputable sources. Please see the explanation in the "WTS-1B: Appendix Two" text for futher discussion of crop coefficients.

The monthly value of the crop nitrogen uptake (U) can be calculated according to the equation included on the Table. Please see the discussion in the "WTS-1B: Appendix Two" text regarding "U" values for alfalfa crops or sites that do not remove crop cuttings. If a different distribution of monthly "U" is used, due to circumstances such as germination or dormancy periods, then provide documentation explaining the difference.

To calculate the monthly value for $Lw_{(n)}$, perform the calculation for each month as outlined in Worksheet 2-A, using the monthly values for "U", "P", "ET", and "Cn", and input the result in the table below. Since this form is crop-specific, a value of zero is acceptable when the crop is not in season; however, use of a zero should be explained.

Monthly U (lb/ac-mo) = U (lb/ac-yr) x ET(in/mo) ÷ ET (total in/yr)

Million Gallons Per Month = $Lw_{(c)}$ in/mo x _____ # acres (ea. crop type) ÷ 12 in/ft x 43,560 ft^2/ac x 7.481 gallons/ft^3 ÷ 1,000,000

MGD (Million gallons/day) = M Gallons/mo ÷ Days/mo

Month	**Days/Mo**	**P (in/mo)**	**ET (in/mo)**	**U (lb/ac-mo)**	**$Lw_{(n)}$ (in/mo)**	**M Gals/Mo**	**MGD of Reclm'd Water**
Jan	31						
Feb	28/29						
Mar	31						
Apr	30						
May	31						
Jun	30						
Jul	31						
Aug	31						
Sep	30						
Oct	31						
Nov	30						
Dec	31						
	Totals:					Note: The totals for P, ET and $Lw_{(n)}$ should approximate the annual values used or calculated in Worksheet 2-A	

Worksheet 2-C: *Regardless of the limiting hydraulic loading rate that was defined during the design phase, Worksheet 2-C is designed to be used to provide the Division with the required annual report of effluent and fertilizer usage.*

Effluent N Applied = _____ x _____ (mg/l) x 8.34 x _____ ÷ _____ x _____
(lb/ac-mo) MGD Applied Effluent N Conc. # days/mo # Acres (1 -"f") (i.e. 0.2.)

Fertilizer N Applied = _____ Monthly Fertilizer used (lbs/mo) x _____ % N in Fertilizer (as a fraction) ÷ _____ acres
(lb/ac-mo)

Crop Name and Nitrogen Uptake Requirement = _____, _____(lbs/ac-yr)

Month	Days/Mo	Million Gallons Applied (mo)	MGD of Irrigation Water Applied	Effluent N Concentration (mg/l)	Effluent N Applied (lb/ac-mo)	Fertilizer N Applied (lb/ac-mo)	Total N Applied (Effl. N + Fert. N) (lb/ac-mo)
Jan	31						
Feb	28/29						
Mar	31						
Apr	30						
May	31						
Jun	30						
Jul	31						
Aug	31						
Sep	30						
Oct	31						
Nov	30						
Dec	31						
						Total** =	

** The Total N Applied to the crop should be less than the crop's Nitrogen Uptake Requirement. Please see your permit for directions if it is not.

APPENDIX THREE

WORKER HYGIENE FACT SHEETS

This project area uses reclaimed wastewater for irrigation. This reclaimed wastewater comes from the sewage treatment plant and meets the standards required for this level of reuse. Potential risks of disease transmission from the use of the reclaimed water is low, however, some general guidelines (listed below), should be followed protect you from becoming ill when working with reclaimed water:

1. Do not drink the reclaimed water or use the reclaimed water for washing.

2. Always wash hands and face with clean water and soap before eating, smoking, or drinking.

3. Wear rubber gloves when working on the irrigation system.

4. Try to keep the irrigation water off your skin and clothes as much as possible.

5. Always treat cuts immediately before continuing with work on the irrigation system.

6. Make sure the area is clear of people that may get sprayed before running the irrigation system.

7. Report any problems to your supervisor that you feel could pose a risk.

APPENDIX FIVE

REUSE REFERENCE LISTS

Literature References For Reclaimed Water Use Management

1. "Guidelines for Using Disinfected Recycled Water", Awwa California-Nevada Section, 1997 & 1984.

2. "Guidelines for Water Reuse", U S Environmental Protection Agency, 1992.

3. "Land Treatment of Municipal Wastewater", U S Environmental Protection Agency, 1981.

4. "Nevada Irrigation Guide", US Department of Agriculture, Soil Conservation Service, 1981.

5. Wastewater Reuse For Golf Course Irrigation, US Golf Association, 1994, Lewis Publishers.

6. Water Reuse Manual of Practice, Water Environment Federation 1989.

7. Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy, 1991, Mcgraw-hill Publishers.

8. Irrigation with Reclaimed Municipal Wastewater- A guidance manual. G.S. Pettygrove and T. Asano, 1985, Lewis Publishers.

Contacts for Technical and Regulatory Guidance

1. **Nevada Division of Environmental Protection, Bureau of Water Pollution Control**
   333 West Nye Lane, Carson City, NV, 89706 . . . . . (775) 687-4670

2. **Nevada Divsion of Water Resources**
   123 West Nye Lane, Carson City, NV 89705 . . . . . (775) 687-4380

3. **Nevada Division of Health**
   505 East King Street, Carson City, NV 89710 . . . . . (775) 687-4750

4. **Desert Research Institute**
   7010 Dandini Boulevard, Reno, NV 89506 . . . . . (775) 673-7300

5. **Natural Resource Conservation Service (NRCS)**
   1528 U.S. Highway 395, Minden, NV 89410 . . . . . (775) 883-2623

   5301 Longley Lane, Building F, Room 201, Reno, NV 89511 . . . . . (775) 784-5875

6. **University of Nevada Cooperative Extension**
   2345 Redrock Street, Suite 100, Las Vegas, NV 89146-3160 . . . . . (702) 222-3130

7. **U.S. Agriculture Department**
   920 Valley Road, Reno, NV 89512 . . . . . (775) 784-6057

8. **Center for Urban Water Conservation - UNLV Dept. of Biology**
   Las Vegas, Nevada 89157-4004 . . . . . (702) 895-3853

APPENDIX SIX

NEVADA ADMINISTRATIVE CODE - REUSE REGULATIONS

Use of Treated Effluent for Irrigation

445A.275 General requirements and restrictions.

1. A person shall not use treated effluent for irrigation unless he has:
   (a) Submitted to the division and has received the approval of the division of a plan for the management of effluent; and
   (b) Obtained a permit pursuant to NAC 445A.228 to 445A.263, inclusive.

2. A person using treated effluent for irrigation by flooding or sprinklers shall use effluent that has received at least secondary treatment. As used in this subsection:
   (a) "Secondary treatment" means that the biological oxidization of the sewage to a point where the sewage has a 5-day inhibited biochemical oxygen demand concentration of 30 milligrams per liter or less.
   (b) "Five-day inhibited biochemical oxygen demand" means the amount of dissolved oxygen in milligrams per liter required during stabilization of the carbonaceous decomposable organic matter by aerobic bacterialaction at 20 degrees centigrade for 5 days.

3. Any person using treated effluent for irrigation shall post a notice at the site of irrigation warning the general public to avoid contact with the treated effluent.

4. Except as otherwise provided in this subsection, a person shall not use treated effluent to irrigate crops for human consumption. A person may use treated effluent for surface irrigation of fruit bearing trees and nut bearing trees.

5. A person using treated effluent to irrigate by sprinklers shall conduct the irrigation in a manner which inhibits the treated effluent from drifting or carrying outside the buffer zone.

6. A person shall not allow treated effluent used in irrigation to run off the site being irrigated.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.176)

Reviser's Note.

The regulation of the state environmental commission filed with the secretary of state on September 13, 1991, the source of NAC 445A.275 to 445A.280, inclusive, became effective on that date and contains the following provisions not included in NAC:

"Notwithstanding the provisions of sections 2 to 8, inclusive, of this regulation, a person who:

1. Is using treated effluent for irrigation on the effective date of this regulation without having obtained a permit pursuant to NAC 445A.228 to 445A.263, inclusive; and

2. Has submitted to the state department of conservation and natural resources a completed application for obtaining a permit pursuant to NAC 445A.228 to 445A.263, inclusive, within 180 days after the effective date of this regulation,

may continue to use treated effluent for irrigation without having obtained a permit until the state department of conservation and natural resources takes action upon the application for a permit."

445A.276 Spray irrigation: Requirements for bacteriological quality and buffer zone limitations.

1. Treated effluent being used for spray irrigation must meet the following requirement for bacteriological quality and buffer zone limitations:

	Fecal Coliform c.f.u or mpn/100 ml			
Reuse Permitted	A	A(1)	B	C
30-day geometric mean	No limit	200	23	2.2
Maximum daily number	No limit	400	240	23
Minimum Buffer Zone (Feet)	800	400	100	0

2. As used in this section:

(a) Category "A" means irrigation with treated effluent of land used for:

(1) Pasture; or

(2) Other agricultural purposes except growing crops for human consumption, where public access to the site being irrigated is prohibited.

Treated effluent being used for activities falling within category A must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category A or meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category A(1).

(b) Category "B" means irrigation with treated effluent for land used for:

(1) A golf course, cemetery or greenbelt where public access to the site being irrigated is controlled and human contact with the treated effluent does not occur;

(2) An impoundment where all activities are prohibited and human contact with the treated effluent does not occur; or

(3) Any combination of a use listed in paragraph (a) and a use listed in subparagraph (1) or (2) of this paragraph.

Treated effluent being used for activities falling within category B must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category B.

(c) Category "C" means irrigation with treated effluent of land used for:

(1) A cemetery, highway median, greenbelt, park, playground or residential or commercial lawn where public access to the site being irrigated is controlled and human contact with the treated effluent cannot reasonably be expected;

(2) Impoundments where full body contact with the treated effluent cannot reasonably be expected;

(3) Any other purpose not included in category A or B; or

(4) Any combination of an activity listed in paragraph (a) or (b) and an activity listed in subparagraph (1), (2) or (3) of this paragraph.

Treated effluent being used for activities falling within category C must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category C.

(d) "C.f.u. or mpn/100 ml" means colony forming units or most probable number per 100 milliliters of the treated effluent.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--Substituted in revision for NAC 445.1765)

445A.277 Exceptions to requirements for buffer zone and control of public access. A buffer zone and control of public access is not required where treated effluent is used for irrigation of land used for a cemetery, golf course, greenbelt, impoundment where full body contact can reasonably be expected, park, playground or commercial or residential lawn, if the treated effluent:

1. Has a total coliform concentration of 2.2, or less, per 100 milliliters of the treated effluent as a 30 day geometric mean; and
2. Has a total coliform concentration of 23, or less, per 100 milliliters of the treated effluent as a maximum daily number.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.177)

445A.278 Drip or surface irrigation of landscape: Minimum level of disinfection. The minimum level of disinfection for drip irrigation of landscape and surface irrigation of landscape with treated effluent in areas where public access is controlled is 200 fecal coliform per 100 milliliters of the treated effluent as a 30 day geometric mean and 400 fecal coliform per 100 milliliters of the treated effluent as a maximum daily number.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.1775)

445A.279 Determining quality of effluent: Storage reservoirs excluded from treatment process. For the purpose of determining the quality of effluent, storage reservoirs do not constitute part of the treatment process.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.178)

445A.280 Waiver or modification of requirements. The director may waive compliance with or modify any requirement of NAC 445A.275 to 445A.280, inclusive, for a specific project of irrigation upon his determination that because of the size, type or location of the project of irrigation, the wavier or modification is consistent with the policy set forth in NRS 445A.305.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.1785)